

**LOWER DUWAMISH WATERWAY BASELINE SEEP
COLLECTION AND CHEMICAL ANALYSES - QUALITY
ASSURANCE PROJECT PLAN**

DRAFT FINAL

Prepared for

Lower Duwamish Waterway Group

For submittal to

US Environmental Protection Agency

January 25, 2018

Prepared by:  Windward
environmental LLC

200 West Mercer Street, Suite 401 s Seattle, Washington s 98119

Title and Approval Page
Seep Collection And Chemical Analyses
Quality Assurance Project Plan

Windward Project Manager

Name

Date

Windward Field Coordinator

Name

Date

Windward QA/QC Manager

Name

Date

EPA Project Manager

Name

Date

EPA QA/QC Manager

Name

Date

Distribution List

This list identifies all individuals who will receive a copy of the approved quality assurance project plan, either in hard copy or electronic format, as well as any subsequent revisions.

- u Elly Hale, EPA Project Manager
- u Kathy Godtfredsen, Windward Project Manager
- u Susan McGroddy, Windward Task Manager
- u Thai Do, Windward Field Lead
- u Suzanne Dudziak, Greylock Consulting Lead
- u Donald Brown, EPA QA/QC Manager
- u Amara Vandervort, Windward QA/QC Manager
- u Chemistry Project Managers:
 - u Sue Dunnihoo (Analytical Resources, Inc.)
 - u Georgina Brooks (Axys)
- u Lower Duwamish Group:
 - u Brian Anderson, Joe Flaherty (The Boeing Company)
 - u Dave Schuchardt, Allison Crowley, Pete Rude (City of Seattle)
 - u Jeff Stern, Debra Williston (King County)
 - u Joanna Florer (Port of Seattle)

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Acronyms

%RSD	percent relative standard deviation
AOC	Administrative Order on Consent
ARI	Analytical Resources, Inc.
Axys	Axys Analytical Services Ltd.
BBP	butyl benzyl phthalate
BDC	Boeing Developmental Center
CFR	Code of Federal Regulations
COC	chain of custody
CSL	cleanup screening level
CV-AFS	cold vapor-atomic fluorescence spectrometry
DL	detection limit
DO	dissolved oxygen
DOC	dissolved organic carbon
DQI	data quality indicator
DQO	data quality objective
ECD	electron capture data
Ecology	Washington State Department of Ecology
EDL	estimated detection limit
EIM	Environmental Information Management
EPA	US Environmental Protection Agency
FC	field coordinator
FNU	Formazin Nephelometric Unit
GC/MS	gas chromatography/mass spectrometry
GPC	gel permeation chromatography
GPS	global positioning system
HDPE	high-density polyethylene
HpCDD	heptachlorodibenzo- <i>p</i> -dioxin
HpCDF	heptachlorodibenzofuran

HRGC/HRMS	high-resolution gas chromatography/high-resolution mass spectrometry
HSP	health and safety plan
HxCDD	hexachlorodibenzo- <i>p</i> -dioxin
HxCDF	hexachlorodibenzofuran
ICP-MS	inductively coupled plasma-mass spectrometry
ID	identification
LCS	laboratory control sample
LDW	Lower Duwamish Waterway
LDWG	Lower Duwamish Waterway Group
MDL	method detection limit
MLLW	mean lower low water
MS	matrix spike
MSD	matrix spike duplicate
NIST	National Institute of Standards and Technology
NTU	nephelometric turbidity unit
OCDD	octachlorodibenzo- <i>p</i> -dioxin
OCDF	octachlorodibenzofuran
OSHA	Occupational Safety and Health Administration
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyl
PCP	pentachlorophenol
PeCDD	pentachlorodibenzo- <i>p</i> -dioxin
PeCDF	pentachlorodibenzofuran
PM	project manager
PPE	personal protective equipment
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RAL	remedial action level

RI	remedial investigation
RL	reporting limit
RM	river mile
ROD	Record of Decision
RPD	relative percent difference
SCO	sediment cleanup objective
SDG	sample delivery group
SDOT	Seattle Department of Transportation
SIM	selected ion monitoring
SM	Standard Methods
SMS	Washington State Sediment Management Standards
SR	state route
SVOC	semivolatile organic compound
TBAS	tetrabutylammonium sulfite
TCDD	tetrachlorodibenzo- <i>p</i> -dioxin
TCDF	tetrachlorodibenzofuran
TEQ	toxic equivalent ^{tee}
TM	task manager
TOC	total organic carbon
TSS	total suspended solids
UCT-KED	universal cell technology-kinetic energy discrimination
VOC	volatile organic compounds
Windward	Windward Environmental LLC
WQC	water quality criteria

1 Introduction

This quality assurance project plan (QAPP) describes the quality assurance (QA) objectives, methods, and procedures for collecting seep water from the Lower Duwamish Waterway (LDW) for chemical analyses. As described in the *Pre-Design Studies Work Plan* (Windward and Integral 2017), hereafter referred to as the Work Plan, seep water data will be collected and analyzed to address the third amendment to the Administrative Order on Consent (AOC) (EPA 2016d).

The Work Plan presented the conceptual study design for seep water collection and associated chemical analyses (Windward and Integral 2017). This QAPP presents the detailed seep water study design, including details on project organization, field data collection, laboratory analyses, and data management.

US Environmental Protection Agency (EPA) guidance for QAPPs has been followed in preparing this document (EPA 2002). The remainder of this QAPP is organized into the following sections:

- u Section 2 – Project Objectives and Description
- u Section 3 – Project Organization and Responsibilities
- u Section 4 – Data Generation and Acquisition
- u Section 5 – Assessment and Oversight
- u Section 6 – Data Validation and Usability
- u Section 7 – References

Appendix A to this QAPP is a health and safety plan (HSP) designed to protect on-site personnel from physical, chemical, and other hazards posed by the field sampling effort. Field collection forms are included as Appendix B. Laboratory methods and the associated reporting limits (RLs) are provided in Appendix C.

2 Project Objectives and Description

EPA issued a Record of Decision (ROD) for the LDW Superfund site on November 21, 2014 (EPA 2014b). The ROD described the selected sediment remedy for the LDW, and identified monitoring and source control activities, including sampling of LDW media. This QAPP focuses on sampling of seep water.

2.1 STUDY OBJECTIVE

Per the third amendment to the AOC (EPA 2016d), seep samples will be collected and analyzed as part of the pre-design studies to aid the Washington State Department of Ecology (Ecology) in source identification. Specifically, seep sampling will be conducted in areas where existing groundwater data are insufficient to determine if groundwater may be a significant ongoing source of contamination.

2.2 PROJECT APPROACH AND SCHEDULE

Most of the significant seeps in the LDW have been sampled as part of the remedial investigation (RI) or other programs (Windward 2004a, 2010). Seep sampling locations for the pre-design study effort, as discussed in this QAPP, are based on a review of this information, available groundwater data (Windward 2017), and the criteria outlined in the flow chart depicted in Figure 2-1, which includes a reconnaissance survey. The selection process and the seeps selected for the reconnaissance survey are described in Section 4.1.

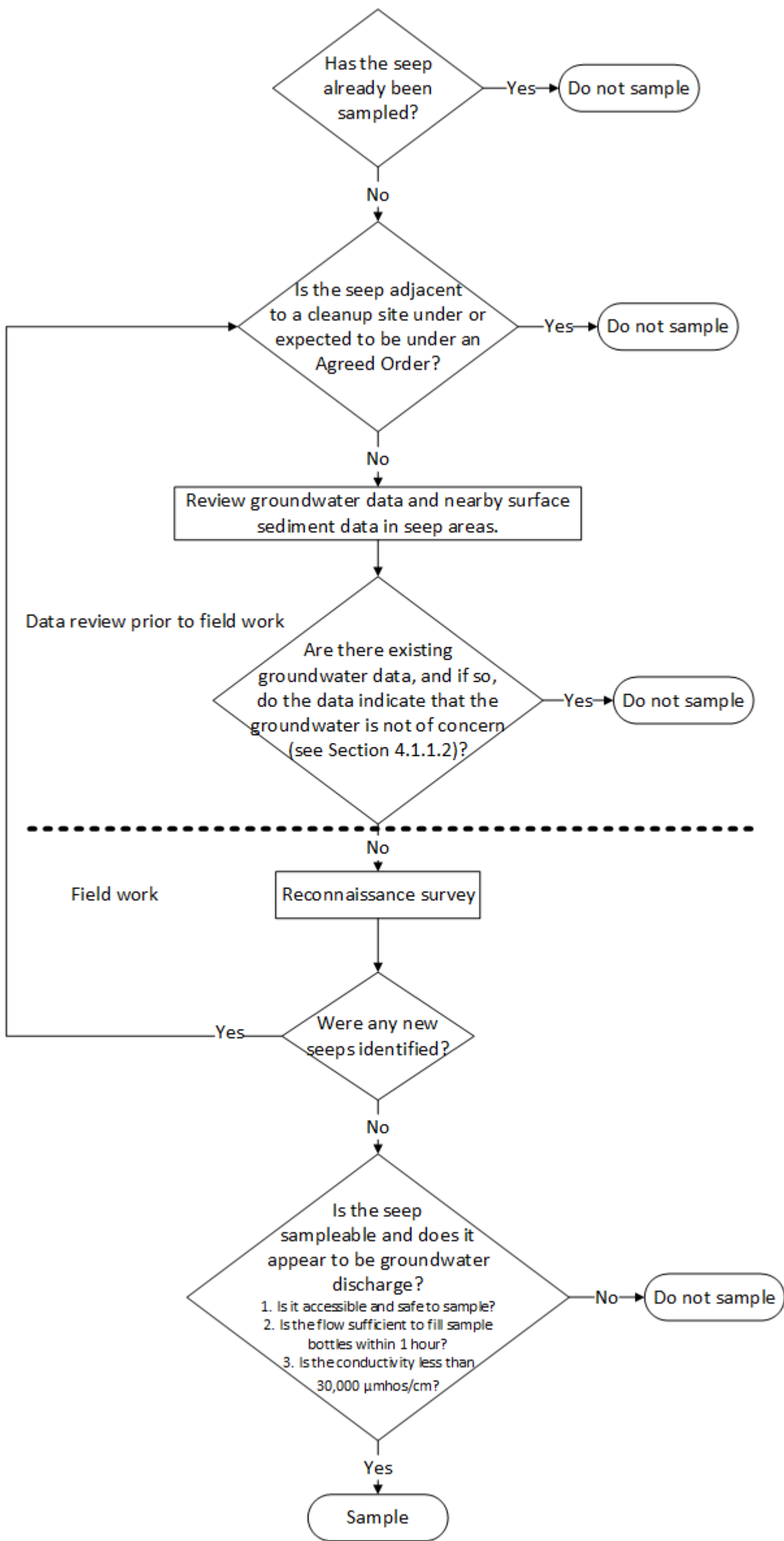


Figure 2-1. Selection criteria to determine if seeps should be sampled

In the LDW, freshwater moving downstream overlies a tidally driven saltwater wedge. These conditions result in the occurrence of saline water in the groundwater zone beneath the LDW. Less dense, fresh groundwater will not mix or migrate readily into these saline zones. As a result, fresh groundwater migrating beneath upland areas is likely to discharge upwards primarily into shallower areas of the LDW and emerge as seeps that can be sampled under low tide conditions. Based on past field experience, most of the seeps can be observed when the tide is below +1 ft mean lower low water (MLLW). Conducting the field effort during daylight low tides will maximize the observable intertidal area and will also ensure that tidal hydrostatic pressure has diminished, allowing seep flows to reach maximum rates (Windward 2004b).

Table 2-1 shows the daylight times¹ that the tide will be below + 1 ft MLLW from May through June 2018. Based on the information presented in Table 2-1, the reconnaissance survey will be conducted from May 15 to 18, 2018. Sampling during rain events could result in sampling of stormwater, not seep water. Therefore, seeps will not be sampled if there is visible storm runoff. If a significant rain event resulting in visible storm runoff (greater than 0.1 in. in 24 hours²) occurs during the proposed survey dates, potential backup dates are May 19, 20, 29, 30, and 31, 2018. These survey dates were selected because of the negative tides that will occur during this period.

Table 2-1. Tidal lows available May through June 2018

Dates	Low Tide Start	Low Tide End	Duration of Work Time in Hours ^a	Low Tide Elevation (ft MLLW)
5/15/18	9:45	13:30	3.75	-1.75
5/16/18	10:00	14:30	4.5	-2.52
5/17/18	10:45	15:15	4.5	-2.92
5/18/18	11:30	16:00	4.5	-2.88
5/19/18	12:30	16:45	4.25	-2.42
5/20/18	13:30	17:30	4	-1.59
5/29/18	9:45	13:30	3.75	-1.47
5/30/18	10:15	14:15	4	-1.62
5/31/18	10:45	14:45	4	-1.59
6/12/18	8:30	12:30	4	-2.04
6/13/18	9:00	13:30	4.5	-2.98
6/14/18	9:30	14:15	4.75	-3.55
6/15/18	10:15	15:15	5	-3.67
6/16/18	11:15	16:00	4.75	-3.34

¹ Daylight times are targeted for crew safety and to facilitate observations during sampling.

² The threshold of 0.1 inches in 24 hours is based on best professional judgement based on previous experience.

Dates	Low Tide Start	Low Tide End	Duration of Work Time in Hours ^a	Low Tide Elevation (ft MLLW)
6/26/18	8:45	12:45	4	-1.31
6/27/18	9:15	13:15	4	-1.53
6/28/18	9:45	13:45	4	-1.61
6/29/18	10:30	14:30	4	-1.55

^a Time tide elevation is below +1 ft MLLW.

MLLW – mean low low water

The seep sampling field event is scheduled for June 12 through 16, 2018 (5 days). This schedule assumes up to four samples per day as conditions allow, based on experience from previous seep sampling performed by Windward Environmental LLC (Windward) in 2004. Depending on the final number of samples, two field crews may be required. Potential backup dates for seep sampling, in the event of [visible storm runoffsignificant rainfall](#), are June 26 through 29, 2018.

Chemical analysis of the seep samples will require approximately four weeks. Data validation will be completed approximately three weeks after receipt of the chemistry data. EPA will be notified when the final data validation report has been received. A draft seep sampling data report (Work Plan Task 5) will be submitted to EPA 21 days after receipt of the final validated analytical results (Windward and Integral 2017). A draft final seep sampling data report will be submitted to EPA 30 days after receipt of EPA's comments on the draft data report. Final validated data will be submitted to Ecology's Environmental Information Management (EIM) system and Scribe within 30 days of EPA approval of the data report. Seep data will be evaluated in the data evaluation report (Work Plan Task 6).

3 Project Organization and Responsibilities

The overall project organization and the individuals responsible for the various tasks required for seep sample collection and analysis are shown in Figure 3-1. Responsibilities of project team members, as well as laboratory project managers (PMs), are described in the following sections.

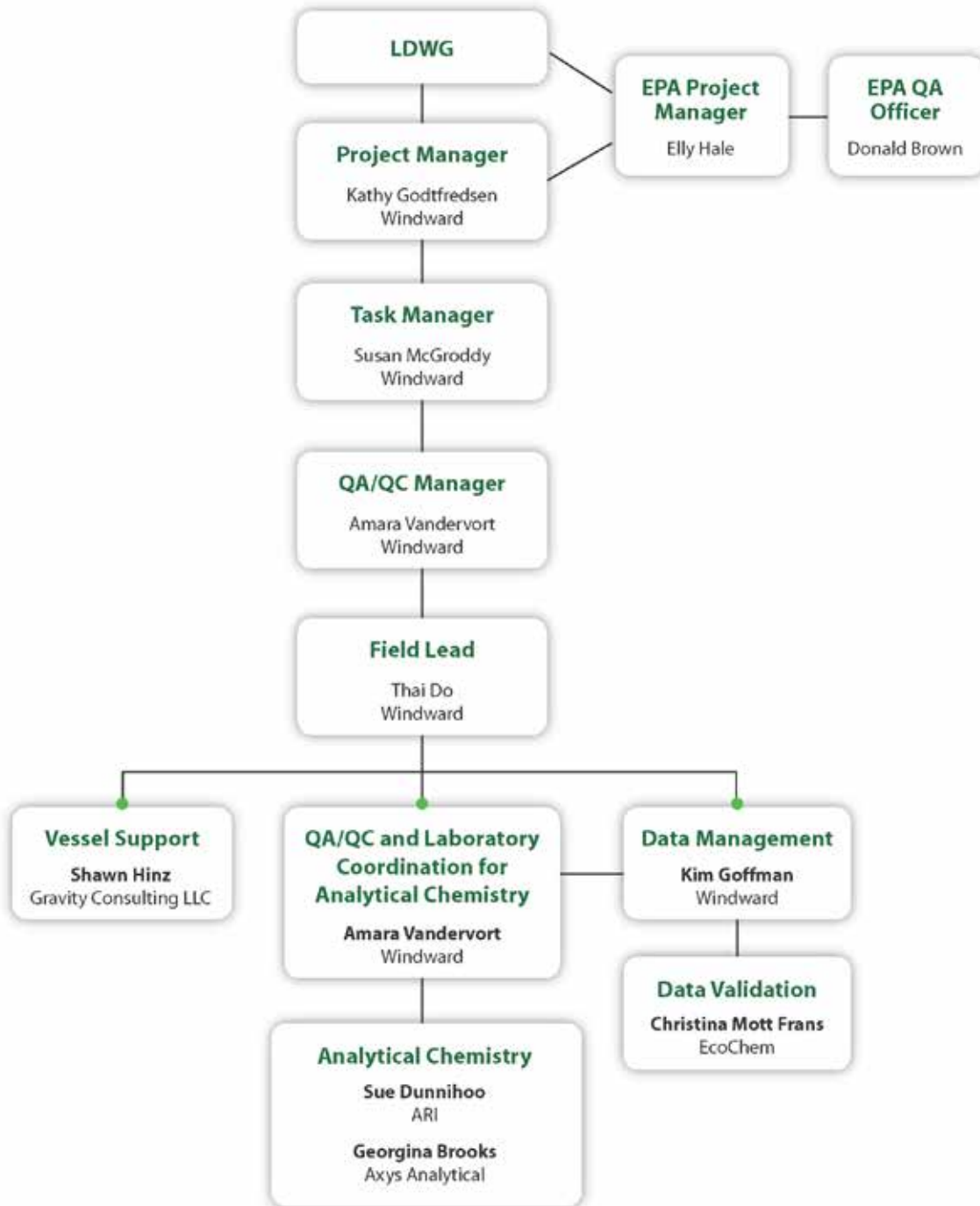


Figure 3-1. Project organization and team responsibilities

3.1 PROJECT MANAGEMENT

Both the Lower Duwamish Waterway Group (LDWG) and EPA are involved in all aspects of this project, including discussion, review, and approval of this QAPP, and interpretation of the results of the investigation. Elly Hale is the EPA PM for the pre-design studies (EPA 2016d).

Kathy Godtfredsen is the Windward PM. In this capacity, she will be responsible for overall project coordination, and for providing oversight for planning and coordination, work plans, all project deliverables, and performance of the administrative tasks needed to ensure timely and successful completion of the project. She will also be responsible for coordinating with LDWG and EPA on schedule, deliverables, and other administrative details. Dr. Godtfredsen can be reached as follows:

Dr. Kathy Godtfredsen
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.577.1283
E-mail: kathyg@windwardenv.com

Susan McGroddy is the Windward monitoring task manager (TM). As TM, she will be responsible for communicating with the Windward PM on the progress of project tasks, conducting detailed planning and coordination, and monitoring and communicating any deviations from this QAPP. Significant deviations from this QAPP will be further reported to representatives of LDWG and EPA. Dr. McGroddy can be reached as follows:

Dr. Susan McGroddy
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5421
E-mail: susanm@windwardenv.com

3.2 FIELD COORDINATION

Thai Do is the Windward field coordinator (FC). As FC, he will be responsible for managing field sampling activities and providing general field and QA/quality control (QC) oversight. Suzanne Dudziak of Greylock Consulting LLC will assist Mr. Do in collecting seep samples. Mr. Do will ensure that appropriate protocols are observed for sample collection, preservation, and holding times, and will oversee delivery of environmental samples to the designated laboratories for chemical analyses. The FC will report deviations from this QAPP to the TM and PM for consultation. Significant deviations from this QAPP will be further reported to representatives of LDWG and EPA. Mr. Do can be reached as follows:

Mr. Thai Do
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5407³
Email: thaid@windwardenv.com

Shawn Hinz is the boat captain. He will be responsible for operating the boat and will coordinate closely with the FC to ensure that samples are collected in keeping with the methods and procedures presented in this QAPP. Mr. Hinz can be reached as follows:

Mr. Shawn Hinz
Gravity Consulting LLC
32617 Southeast 44th Street
Fall City, WA 98024
Mobile: (b) (6)
Email: shawn@gravity.com

3.3 QUALITY ASSURANCE/QUALITY CONTROL

Amara Vandervort is the Windward QA/QC coordinator. In this capacity, she will oversee coordination of the field sampling and laboratory programs, and will supervise data validation and project QA coordination, including coordination with the analytical laboratories and the EPA QA officer, Donald Brown. Ms. Vandervort will also maintain the official approved QAPP and ensure that the appropriate parties receive any updated versions of the QAPP. Ms. Vandervort can be reached as follows:

Ms. Amara Vandervort
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5415
Email: amarav@windwardenv.com

Mr. Brown can be reached as follows:

Mr. Donald Brown
US Environmental Protection Agency, Region 10
1200 6th Avenue
Seattle, WA 98101
Telephone: 206.553.0717
Email: brown.donaldm@epa.gov

³ A mobile phone number will be provided prior to field sampling.

Independent third-party chemical data review and validation will be provided by EcoChem. The PM at EcoChem can be reached as follows:

Ms. Christina Mott Frans
EcoChem
1011 Western Avenue, Suite 1006
Seattle, WA 98104
Telephone: 206.508.2110
Email: cmfrans@ecochem.net

3.4 LABORATORY RESPONSIBILITIES

Amara Vandervort of Windward is the laboratory coordinator for the analytical chemistry laboratories. Analytical Resources, Inc. (ARI) will perform all chemical analyses on the seep samples, with the exception of analyses for dioxins/furans, which will be performed by Axys Analytical Services Ltd. (Axys).

The laboratory PM at ARI can be reached as follows:

Ms. Susan Dunnihoo
Analytical Resources, Inc.
4611 South 134th Place
Tukwila, WA 98168-3240
Telephone: 206.695.6207
Email: limsadm@arilabs.com

The laboratory PM at Axys can be reached as follows:

Ms. Georgina Brooks
Axys Analytical Services Ltd.
2045 West Mills Road
Sidney, British Columbia V8L 5X2
Canada
Telephone: 250.655.5801
Email: Georgina.Brooks@sgs.com

The laboratories will meet the following requirements:

- u Adhere to the methods outlined in this QAPP, including those methods referenced for each procedure.
- u Adhere to documentation, custody, and sample logbook procedures.
- u Implement QA/QC procedures defined in this QAPP.
- u Meet all reporting requirements.
- u Deliver electronic data files as specified in this QAPP.
- u Meet turnaround times for deliverables as described in this QAPP.

- u Allow EPA and the QA/QC manager, or a representative, to perform laboratory and data audits.

3.5 DATA MANAGEMENT

Kim Goffman of Windward will oversee data management, and will ensure that analytical data are incorporated into the LDW database with appropriate qualifiers following acceptance of the data validation. QA/QC of the database entries will ensure accuracy for use in the pre-design studies. Ms. Goffman can be reached as follows:

Ms. Kim Goffman
Windward Environmental LLC
200 West Mercer Street, Suite 401
Seattle, WA 98119
Telephone: 206.812.5414
Email: kimg@windwardenv.com

3.6 SPECIAL TRAINING/CERTIFICATION

The Superfund Amendments and Reauthorization Act of 1986 required the Secretary of Labor to issue regulations through the Occupational Safety and Health Administration (OSHA) providing health and safety standards and guidelines for workers engaged in hazardous waste operations. Accordingly, 29 Code of Federal Regulations (CFR) 1910.120 requires that employees be given the training necessary to provide them with the knowledge and skills to enable them to perform their jobs safely and with minimum risk to their personal health. All sampling personnel will have completed the 40-hour HAZWOPER training and 8-hour refresher courses, as necessary, to meet OSHA regulations.

Also, ARI and Axys have current environmental laboratory accreditation from Ecology for the methods to be performed.

3.7 DOCUMENTATION AND RECORDS

All field activities and laboratory analyses will be documented following the protocols described in this section. In addition, data reduction rules and data report formats are provided herein.

3.7.1 Field observations

All field activities will be recorded in a field logbook maintained by the FC or designee. The field logbook will provide a description of all sampling activities, conferences between the FC and EPA oversight personnel associated with field sampling activities, sampling personnel, and weather conditions, as well as a record of all modifications to the procedures and plans identified in this QAPP and the HSP (Appendix A). The field logbook will consist of bound, numbered pages, and all entries will be made in indelible ink. Photographs, taken with a digital camera, will provide additional

documentation of the seep collection activities. The field logbook is intended to provide sufficient data and observations to enable participants to reconstruct events that occurred during the sampling period.

The following field data collection sheets, included as Appendix B, will also be used to record pertinent information after sample collection:

- u Seep Reconnaissance Survey Forms A-C
- u Seep Collection Form
- u Protocol Modification Form

Information regarding equipment calibration and other sampling activities will be documented in the field logbook.

3.7.2 Laboratory records

The chemistry laboratories will be responsible for internal checks on sample handling and analytical data reporting, and will correct errors identified during the QA review. The laboratory data packages will be submitted electronically and will include the following:

- u **Project narrative:** This summary, in the form of a cover letter, will present any problems encountered during any aspect of sample analyses. The summary will include, but not be limited to, discussion of QC, sample shipment, sample storage, and analytical difficulties. Any problems encountered by the laboratory will be documented, as will their resolutions. In addition, operating conditions for instruments used for the analysis of each suite of analytes and definitions of laboratory qualifiers will be provided.
- u **Records:** Legible copies of the chain of custody (COC) forms will be provided as part of the data package. This documentation will include the time of receipt and the condition of each sample received by the laboratory. Additional internal tracking of sample custody by the laboratory will also be documented.
- u **Sample results:** The data package will summarize the results for each sample analyzed. The summary will include the following information, as applicable:
 - u Field sample identification (ID) code and the corresponding laboratory ID code
 - u Sample matrix
 - u Date of sample extraction/digestion
 - u Date and time of analysis
 - u Volume used for analysis
 - u Final dilution volumes or concentration factor for the sample
 - u Identification of the instruments used for analysis

- u Method detection limits (MDLs) and RLs⁴
- u All data qualifiers and their definitions
- u **QA/QC summaries:** These summaries will contain the results of all QA/QC procedures. Each QA/QC sample analysis will be documented with the same information required for the sample results (see above). The laboratory will make no recovery or blank corrections except for isotope dilution method correction prescribed in EPA method 1613b. The required summaries are as follows:
 - u The calibration data summary will contain the concentrations of the initial calibration and daily calibration standards and the date and time of analysis. The response factor, percent relative standard deviation (%RSD), relative percent difference (RPD), and retention time for each analyte will be listed, as appropriate. Results for standards analyzed to indicate instrument sensitivity will be reported.
 - u The internal standard area summary will report the internal standard areas, as appropriate.
 - u The method blank analysis summary will report the method blank analysis associated with each sample and the concentrations of all compounds of interest identified in these blanks.
 - u The surrogate spike recovery summary will report all surrogate spike recovery data for organic analyses. The names and concentrations of all compounds added, percent recoveries, and QC limits will be listed.
 - u The labeled compound recovery summary will report all labeled compound recovery data for EPA method 1613b analyses. The names and concentrations of all compounds added, percent recovery, and QC limits will be listed.
 - u The matrix spike (MS) recovery summary will report the MS or MS/matrix spike duplicate (MSD) recovery data for analyses, as appropriate. The names and concentrations of all compounds added, percent recoveries, and QC limits will be included. The RPDs for all MS and MSD analyses will be reported.
 - u The matrix duplicate summary will report the RPDs for all matrix duplicate analyses. The QC limits for each compound or analyte will be listed.
 - u The laboratory control sample (LCS) analysis summary will report the results of the analyses of LCSs. The QC limits for each compound or analyte will be included.

⁴ The term MDL includes other types of detection limits (DLs), such as estimated detection limit (EDL) values calculated for dioxin/furan congeners.

- u The relative retention time summary will report the relative retention times for the primary and confirmational columns of each analyte detected in the samples, as appropriate.
- u The ion abundance ratio summary for samples analyzed by EPA method 1613b will report computed ion abundance ratios compared to theoretical ratios listed in the applicable method.
- u **Original data:** Legible copies of the original data generated by the laboratory will be provided, including the following:
 - u Sample extraction/digestion, preparation, and cleanup logs
 - u Instrument specifications and analysis logs for all instruments used on days of calibration and analysis
 - u Reconstructed ion chromatograms for all samples, standards, blanks, calibrations, spikes, replicates, and LCSs
 - u Enhanced and unenhanced spectra of target compounds detected in field samples and method blanks, with associated best-match spectra and background-subtracted spectra, for all gas chromatography/mass spectrometry (GC/MS) analyses
 - u Quantitation reports for each instrument used, including reports for all samples, blanks, calibrations, MSs/MSDs, laboratory replicates, and LCSs
 The contract laboratories for this project will submit data electronically, in EarthSoft EQuIS® standard four-file or EZ_EDD format. Guidelines for electronic data deliverables for chemical data are provided on the EarthSoft website, <http://www.earthsoft.com/en/index.html>, and additional information will be communicated to the laboratories by the project QA/QC coordinator or data manager. All electronic data submittals must be tab-delimited text files with all results, MDLs (as applicable), and RLs reported to the appropriate number of significant figures. If laboratory replicate analyses are conducted on a single submitted field sample, the laboratory sample identifier must distinguish among the replicate analyses.

3.7.3 Data reduction

Data reduction is the process by which original data (analytical measurements) are converted or reduced to a specified format or unit to facilitate analysis of the data. Data reduction requires that all aspects of sample preparation that could affect the test result—such as sample volume analyzed or dilutions required—be taken into account in the final result. It will be the laboratory analyst’s responsibility to reduce the data, which will be subjected to further review and reduction by the laboratory PM, the Woodward TM, the QA/QC coordinator, and independent reviewers. The data will be generated in a format amenable to review and evaluation. Data reduction may be

performed manually or electronically. If performed electronically, all software used must be demonstrated to be true and free from unacceptable error.

3.7.4 Data report

A data report will be prepared documenting all activities associated with the collection, handling, and analysis of samples, as specified in Task 5 of the Work Plan (Windward and Integral 2017). At a minimum, the following information will be included in the data report:

- u Summary of all field activities, including descriptions of any deviations from the approved QAPP
- u Sampling locations reported in latitude and longitude to the nearest one-tenth of a second and in northing and easting to the nearest foot
- u *In situ* seep flow and water quality measurements during reconnaissance and the seep sampling event
- u Summary of the chemical data QA/QC review
- u Results from the analyses of field samples, included as summary tables in the main body of the report, data forms submitted by the laboratories, and cross-tab tables produced from Windward's database
- u Copies of field logs and photographs (appendix)
- u Copies of COC forms (appendix)
- u Data validation report (appendix)

Once the data report has been approved by EPA, a database export will be created from Windward's database. The data will be exported in two formats: one that is compatible with Ecology's EIM System, and one that is compatible with EPA's Scribe database.

3.7.5 Data storage and backup

All electronic files related to the project will be stored on a secure server on Windward's network. The server contents are backed up on an hourly basis, and a copy of the backup is uploaded nightly to a secure off-site facility.

4 Data Generation and Acquisition

Seep samples will be collected, processed, and analyzed according to the procedures described in this section. In addition, QA/QC, instrument maintenance and calibration, non-direct measurement, and data management requirements are provided.

4.1 SAMPLING DESIGN

The sampling design currently includes a pre-screening of potential seep sampling locations, which were chosen using cleanup site information as well as available seep, sediment, and groundwater data prior to conducting a reconnaissance survey. A reconnaissance survey will further screen seeps to be sampled based on sampling location accessibility, flow rate, and conductivity. Any new seeps discovered during the reconnaissance survey will also be screened.

4.1.1 Sampling locations

In keeping with the approach summarized in Figure 2-1, three sources of information as well as best professional judgement were used to determine pre-screening seep sampling locations. These sources are listed below and discussed in the following subsections:

- u Existing seep data and cleanup site locations
- u Existing groundwater and surface sediment data
- u Reconnaissance survey data

4.1.1.1 Existing seep data and cleanup site locations

Existing seep data were reviewed to identify the locations of known and previously sampled seeps. From the LDW RI and Work Plan Task 2 dataset (Map 4-1), 122 known seeps were identified, 65 of which had already been sampled and were therefore screened out (Appendix D). Of the remaining 57 seeps, ~~12~~11 were located adjacent to cleanup sites under or expected to be under an Agreed Order; these were screened out, leaving ~~45~~46 seeps (Appendix D).

4.1.1.2 Existing groundwater and surface sediment data

The compiled groundwater data were reviewed, and existing groundwater data from wells in the vicinity of 13 of the remaining ~~45~~46 seeps were identified (Maps 4-2a,b,c). These data were evaluated for sufficiency. Groundwater data from wells near ~~8~~10 of the 13 seeps were not sufficient (i.e., did not include enough analytes or had elevated polychlorinated biphenyl [PCB] detection limits [DLs]; Appendix E) to screen out the corresponding seeps, whereas groundwater data from wells near ~~5~~3 of the 13 seeps were sufficient to screen out the groundwater pathway from a source control perspective.

As part of the screening assessment, existing sediment data were evaluated near seep locations to ensure the sufficiency of adjacent groundwater data. In particular, sediment data were included in the groundwater screen for two reasons:

- u If the groundwater analyte list did not include the full list of chemicals with sediment remedial action levels (RALs), the sediment data were reviewed to ensure that no sediment RAL exceedances are present in that area for those chemicals.
- u If a chemical had “an elevated” concentration in groundwater relative to a ~~highly~~ conservative benchmark,⁵ the sediment data was used to assess whether RAL exceedances for that chemical are present in the vicinity of the seep. For screening purposes only, Washington State marine chronic water quality criteria (WQC) were used as the conservative benchmark.

The results of groundwater and sediment data screening step are presented in Table 4-1. Each of the 43 seeps remaining will be included in the reconnaissance survey being conducted to determine which seeps should be sampled for the full analyte list. Also, wWhere two or more seeps are located close to each other (i.e., within 0.2 ~~river miles~~ [RM] of each other) and also drain the same upland property or drain nearby residential properties or bridge, the ~~seeps will be included in results of the reconnaissance survey as a will be discussed with EPA and Ecology to assess which of the seeps can be grouped to represent an area (e.g., only one of two nearby seeps sampled), and which should be sampled individually. Potential groupings are included in Table 4-1 for reference.~~ group. Of these group seeps, the individual seep with the highest flow rate will be selected for sampling (assuming it meets all other criteria for sampling).

~~The results of groundwater and sediment data screening step are presented in Table 4-1.~~

⁵ There are no established groundwater criteria for sediment recontamination above the RALs. ~~for screening purposes only, Washington State marine chronic water quality criteria were used as a highly conservative threshold.~~

Table 4-1. Seep screening assessment

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation ^a	Upland Property Information and Other Notes	Preliminary Assessment ^{ab}	Rationale for Screening Out or <u>Potential</u> Grouping
SP-01	2.2 E	wells slightly cross-gradient from seep in Slip 3; groundwater analyzed for VOCs; not enough data to screen out seep	adjacent to roadway and near Glacier Marine and Seattle Distribution Center properties	recon	
SP-05	2.6 E	no groundwater data	near border between Seattle Iron and Metals and Puget Sound Truck Lines	recon	
SP-06	2.6 E	no groundwater data	Puget Sound Truck Lines; co-located with SP-07	recon SP-06 and SP-07; target seep with highest flow	co-located with SP-07
SP-07	2.6 E	no groundwater data	Puget Sound Truck Lines; co-located with SP-06		co-located with SP-06
SP-08	2.7 E	groundwater analyzed for full analyte list (except dioxins/furans); metals, naphthalene, 1 VOC, and PCBs below WQC; all other analytes ND; no nearby sediment data	Puget Sound Truck Lines	screen out	groundwater data (all groundwater analyte concentrations ND or < WQC)
SP-11	2.7 E	groundwater analyzed for full analyte list (except dioxins/furans); metals, naphthalene, 1 VOC, and PCBs below marine chronic WQC; all other analytes ND; one nearby PCB CSL exceedance in sediment; multiple PAH SCO exceedances in sediment nearby (sediment locations DENW6721-SSSED-16A-2014 and LDW-SS92)	City of Seattle	screen out	groundwater data (all groundwater analyte concentrations ND or < WQC); all RLs ≤ WQC except for pentachlorophenol; pentachlorophenol not detected in groundwater; RL was 10 µg/L vs. WQC of 7.9 µg/L and Ecology (2016) threshold of 30 or 43 µg/L for the protection of sediment
SP-24	4.2 E	no groundwater data	Boeing; tried to sample during RI (Slip 6) but seep was dry	recon	

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation ^a	Upland Property Information and Other Notes	Preliminary Assessment ^{ab}	Rationale for Screening Out or <u>Potential</u> Grouping
SP-26	4.5 E	groundwater analyzed for 2 metals and select VOCs; no SMS exceedances in numerous nearby sediment samples, <u>except one benzyl alcohol CSL exceedance (sediment locations LDW-SS2085-A, LDW-SS138, R71, EIT049, and R73)</u>	Boeing; adjacent upland parcel (BDC) is a VCP site	screen out	groundwater and sediment data (limited groundwater analyte list but good sediment coverage with no SCO exceedances)
SP-27	5.0 E	no groundwater data	Boeing	recon	
SP-28	4.9 E	no groundwater data	Boeing	recon SP-28 and SP-33; sample seep with highest flow	located near SP-33 and adjacent to same upland property
SP-29	4.9 W	no groundwater data	Boeing Employees Activity Center	recon SP-29, SP-30, SP-31, and SP-32; sample seep with highest flow	seeps located near each other and adjacent to same upland property
SP-30	4.9 W	no groundwater data	Boeing Employees Activity Center		
SP-31	4.9 W	no groundwater data	Boeing Employees Activity Center		
SP-32	4.8 W	no groundwater data	Boeing Employees Activity Center		
SP-33	4.8 E	groundwater analyzed for 2 metals and select VOCs; <u>PCB SCO exceedance nearby</u>	Boeing	recon SP-28 and SP-33; sample seep with highest flow	located near SP-28 and adjacent to same upland property
SP-34	4.6 W	no groundwater data	located adjacent to SR 99 and parcel owned by Muckleshoot Tribe	recon	
SP-35	4.6 E	groundwater analyzed for 2 metals and select VOCs; PCB SCO exceedance nearby <u>(sediment location R75)</u>	Boeing	recon SP-35 and SP-37; sample seep with highest flow	located near SP-37 and adjacent to same upland property
SP-36	4.5 W	no groundwater data	City of Seattle	recon SP-36 and SP-38; sample seep with highest flow	located near SP-38 and adjacent to same upland property owner
SP-37	4.5 E	groundwater analyzed for 2 metals and select VOCs; PCB SCO exceedance nearby but not in nearest sample <u>(sediment location B9a)</u>	Boeing	recon SP-35 and SP-37; sample seep with highest flow	located near SP-35 and adjacent to same upland property

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation ^a	Upland Property Information and Other Notes	Preliminary Assessment ^{ab}	Rationale for Screening Out or <u>Potential</u> Grouping
SP-38	4.4 W	no groundwater data	City of Seattle	recon SP-36 and SP-38; sample seep with highest flow	located near SP-36 and adjacent to same upland property owner
SP-40	4.0 W	no groundwater data	Duwamish Yacht Club; SP-40 and SP-42 on either side of SP-41, which was previously sampled;	recon	
SP-42	3.9 W	groundwater analyzed for 3 metals, 1 PAH, 3 SVOCs; no SCO exceedances in nearby samples (sediment locations R37, R36, and WIT264)	Sea King Industrial Park; SP-40 and SP-42 on either side of SP-41, which was previously sampled	recon	
SP-43	3.8 W	groundwater analyzed for 3 metals, 1 PAH, 3 SVOCs; mercury SCO exceedance and PCB SCO exceedance nearby (sediment locations DR210, LDW-SSSP3-A, LDW-SSSP3-D, LDW-SSSP3-U, LDW-SS117, R25, and DR211)	Boeing	recon	
SP-44	3.4 W	no groundwater data	South Park Bridge	recon	
SP-45	3.3 W	no groundwater data	near residential properties	recon SP-45, SP-46, and SP-47; sample seep with highest flow	seeps located near each other; drain residential properties
SP-46	3.2 W	no groundwater data	near residential properties		
SP-47	3.1 W	no groundwater data	near residential properties		
SP-49	3.0 W	no groundwater data	Silver Bay Logging	recon SP-49 and SP-50; sample seep with highest flow	seeps located near each other and drain same upland property
SP-50	2.9 W	no groundwater data	Silver Bay Logging		
SP-51	2.8 W	no groundwater data	seep is adjacent to 8 th Ave Park, vacant land/land owned by Cassell Point LLC; Hurlen Construction is just downstream	recon	
SP-57	2.0 W	no groundwater data	adjacent to roadway, 1 st Ave bridge, and SDOT property	recon	
SP-58	2.1 W	no groundwater data	located adjacent to SP-59; under 1 st Ave Bridge		

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation ^a	Upland Property Information and Other Notes	Preliminary Assessment ^{ab}	Rationale for Screening Out or Potential Grouping
SP-59	2.1 W	no groundwater data	located adjacent to SP-58; under 1 st Ave bridge	recon SP-58 and SP-59; sample seep with highest flow	seeps located near each other and drain similar environments
SP-63	2.2 E	no groundwater data	Bunge Foods; nearby seeps (S-11 and S-12) not analyzed for PCBs	recon	
SP-65	1.0 W	no groundwater data	Lafarge; located on same property as SP-64	recon SP-65 and SP-66; sample seep with highest flow	seeps located near each other and adjacent to same upland property
SP-66	0.9 W	no groundwater data	Lafarge; located on same property as SP-64		
SP-67	0.8 W	no groundwater data	Port of Seattle	recon SP-67 and SP-68; sample seep with highest flow	seeps located near each other and adjacent to same upland property
SP-68	0.7 W	no groundwater data	Port of Seattle		
SP-70	0.2 W	no groundwater data	General Recycling	recon	
SP-72	0.2 E	no groundwater data	Ash Grove Cement	recon	
SP-73	0.6 E	groundwater analyzed for PAHs, PCBs, select metals; all of the analytes were below the WQC or were ND, except zinc, but no zinc SCO exceedances nearby; no SCO exceedances nearby for chemicals not analyzed in groundwater (sediment locations LDW-SS508, DUD012, DUD209, and DUD013)	Port of Seattle	screen-out recon	groundwater and sediment data (all groundwater analyte concentrations ND or < WQC, except zinc, which did not have SCO exceedance in nearby sediment); however, PCB and mercury RLs greater than chronic WQC
SP-74	0.7 E	groundwater analyzed for PAHs, PCBs and select metals; copper, zinc, and acenaphthene below WQC; all other analytes ND; no nearby sediment data	Port of Seattle	screen-out recon	groundwater data (all groundwater analyte concentrations ND or < WQC); however, PCB and mercury RLs greater than chronic WQC
SP-77	1.1 E	no groundwater data	King County	recon	

Seep	Location (approx. RM)	Groundwater and Sediment Data Evaluation ^a	Upland Property Information and Other Notes	Preliminary Assessment ^{ab}	Rationale for Screening Out or <u>Potential</u> Grouping
SP-78	1.4 E	groundwater analyzed for naphthalene, 3 SVOCs and VOCs; PCB SCO exceedances nearby (sediment locations LDW-SS50, LDW-SS52, TRI-052, LDW-SS2011-D, LDW-SS2011-A, and LDW-SS54)	King County	recon	
SP-79	1.5 E	groundwater analyzed for naphthalene, 3 SVOCs and VOCs	BPB Gypsum Inc.	recon	
SP-81	1.7 E	no groundwater data	Slip 2; Glacier Northwest	recon	

^a ~~In some cases, the groundwater DL was greater than the marine chronic WQC for some chemicals.~~

^{ab} Seeps with a preliminary assessment of "recon" will be included in the reconnaissance survey.

BBP – butyl benzyl phthalate
 BDC – Boeing Developmental Center
 CSL – cleanup screening level
 DL – detection limit
 ND – non-detect
 PAH – polycyclic aromatic hydrocarbon

PCBs – polychlorinated biphenyls
 RI – remedial investigation
[RL – reporting limit](#)
 RM – river mile
 SCO – sediment cleanup objective (benthic)
 SDOT – Seattle Department of Transportation

SMS – Washington State Sediment Management Standards
 SR – state route
 SVOCs – semivolatile organic compounds
 VCP – Voluntary Cleanup Program
 VOCs – volatile organic compounds
 WQC – water quality criteria

4.1.1.3 Selected locations for reconnaissance

Based on the analysis described in Section 4.1.1.2, 439 locations were selected for the reconnaissance survey, [which is](#) discussed in Section 4.1.2 (Map 4-3). Table 4-2 provides the locations of these seeps.

Table 4-2. Reconnaissance seeps locations

Seep Location ID	Potential Group ^a	X	Y	Longitude	Latitude
SP-01		1270793	201470	-122.33	47.54247
SP-05		1271788	199493	-122.326	47.5371
SP-06	SP-06 and SP-07	1272074	199134	-122.325	47.53613
SP-07		1272106	199134	-122.324	47.53613
SP-24		1277552	192967	-122.302	47.51952
SP-27		1278736	190038	-122.297	47.51155
SP-28	SP-28 and SP-33	1278342	190343	-122.299	47.51237
SP-29	SP-29, SP-30, SP-31, and SP-32	1278280	190125	-122.299	47.51177
SP-30		1278533	189981	-122.298	47.51138
SP-31		1278411	190074	-122.298	47.51163
SP-32		1277871	190291	-122.3	47.5122
SP-33	SP-28 and SP-33	1277731	190501	-122.301	47.51277
SP-34		1276855	190335	-122.305	47.51227
SP-35	SP-35 and SP-37	1277113	190719	-122.304	47.51333
SP-36	SP-36 and SP-38	1276630	190844	-122.306	47.51365
SP-37	SP-35 and SP-37	1276958	191014	-122.304	47.51413
SP-38	SP-36 and SP-38	1276541	191387	-122.306	47.51513
SP-40		1275873	193266	-122.309	47.52025
SP-42		1275903	193789	-122.309	47.52168
SP-43		1275851	194501	-122.309	47.52363
SP-44		1274678	196232	-122.314	47.52832
SP-45	SP-45, SP-46, and SP-47	1274213	196685	-122.316	47.52953
SP-46		1273887	196886	-122.317	47.53007
SP-47		1273588	197196	-122.318	47.5309
SP-49	SP-49 and SP-50	1273022	197711	-122.321	47.53228
SP-50		1272864	197873	-122.321	47.53272
SP-51		1272376	198356	-122.323	47.53402
SP-57		1269573	201184	-122.335	47.54162
SP-58	SP-58 and SP-59	1269572	200740	-122.335	47.5404
SP-59		1269565	200782	-122.335	47.54052
SP-63		1270573	200732	-122.331	47.54043

Seep Location ID	Potential Group ^a	X	Y	Longitude	Latitude
SP-65	SP-65 and SP-66	1266743	206164	-122.347	47.55512
SP-66		1266532	206284	-122.348	47.55543
SP-67	SP-67 and SP-68	1266020	206866	-122.35	47.557
SP-68		1265900	207440	-122.35	47.55857
SP-70		1266050	210057	-122.35	47.56575
SP-72		1267080	210736	-122.346	47.56767
SP-73		1267241	208423	-122.345	47.56133
SP-74		1267361	208061	-122.344	47.56035
SP-77		1268127	205985	-122.341	47.5547
SP-78		1268535	204311	-122.339	47.55013
SP-79		1268658	204102	-122.339	47.54957
SP-81		1269545	203124	-122.335	47.54693

^a [The results of the seep reconnaissance will be used, in consultation with EPA and Ecology, to determine which of the seeps in potential groups. If the seeps in this group have acceptable flow and conductivity, the seep with the highest flow with will be sampled for the analytes discussed in Section 4.4.2.](#)

[Ecology – Washington State Department of Ecology](#)

[EPA – US Environmental Protection Agency](#)

ID - identification

4.1.2 Reconnaissance survey

In order to select seeps for sampling, a reconnaissance survey will be conducted to assess accessibility, seep flow, make observations of visual characteristics, and collect field measurements of conventional water quality parameters. Seeps identified in Section 4.1.1.3 will be evaluated in the reconnaissance survey, as well as any potential new seeps that are observed during the survey.

During the reconnaissance survey, seeps identified as inaccessible or deemed unsafe to sample, including those under piers, docks, or other overwater structures, will be documented as such ~~and will not be sampled through the use of photographs and field notes regarding condition observations~~. At safe and accessible seeps, the field team will look for evidence of flow with sufficient volume to sample, and will measure the conventional parameters (temperature, conductivity, turbidity, pH, and dissolved oxygen [DO]). The seep's conductivity will be used to confirm that it is representative of groundwater discharge. Conductivity must be less than 30 mS/cm conductivity,⁶ and the flow rate must be sufficient to generate 3.5 liters of water in an hour, given the time constraints of sampling during low tides. Flow rate estimates will be made at each seep using a stopwatch. The global positioning system (GPS) location of each seep will be recorded, and a stake will be used to mark each seep in the field.

⁶ On average, the conductivity of seawater is 53 mS/cm.

The conventional parameters will be measured in seep water collected in a glass beaker in the field using a multi-parameter water quality meter. The water collection method will be based on best professional judgment in the field based on flow rate and substrate type. Potential methods of water collection, as described in more detail in Section 4.2.2, include:

- u Placement of a glass funnel under the flow of an actively flowing seep from a moderately to steeply sloping embankment
- u Excavation of a pit and placement of a stainless steel bowl that is allowed to fill with seep water (to be used for seeps from which water cannot be collected directly under the flow)
- u Placement of Teflon™ sheeting to direct flow to a stainless steel bowl (to be used for low to moderately flowing seeps)

Seep survey observations and measurements will be recorded on the seep reconnaissance survey forms (Appendix B, forms A through C). At least two photographs will be taken of each seep.

The results of the reconnaissance survey will be briefly summarized in a spreadsheet and emailed to EPA [for EPA approval; maps, notes, and photographs will also be provided.](#); if needed, a meeting will be held to agree upon which seep locations will be sampled for chemical analysis. In addition, EPA oversight staff may be present during the reconnaissance to aid in decision making. All results will be summarized in the data report.

4.1.3 Analytes

Seep samples collected for chemical analysis will be filtered and analyzed for the analyte list discussed in Section 4.4.2. [Samples from a subset of the seeps will not be analyzed for dioxins/furans \(Map 4-4\). Samples from these seeps will be archived for potential analysis of dioxins/furans following a review of the surface sediment and bank data collected nearby. The 19 seeps that will be initially analyzed for dioxins/furans are SP-01, SP-24, SP-40, SP-42, SP-51, SP-57, SP-58, SP-59, SP-63, SP-65, SP-66, SP-67, SP-68, SP-70, SP-72, SP-77, SP-78, SP-79, and SP-81.](#)

[The seeps that will not be except for a subset of the seeps that will not initially be analyzed for dioxins/furans were identified based on the existing surface sediment dioxin/furan toxic equivalent \(TEQ\) values in the vicinity of the seeps. This subset was identified because the sSeeps in areas characterized by surface sediments with TEQs in these discharge areas has <less than 5 ng/kg ng/kg dioxin/furan toxic equivalence \(TEQ\), far less than the RAL of 25 ng/kg \(Map 4-4\) will be archived for potential dioxin/furan analysis if pentachlorophenol is detected in nearby bank samples, or if the dioxin/furan TEQ is greater than the RAL \(25 ng/kg\) in nearby sediment \(Map 4-4\).](#)

Pending review of the bank and sediment data to be collected this field season, seep samples collected upstream of RM 4.4 and in RM 2.5 to RM 2.7 and RM 2.9 to RM 3.9 will not be analyzed for dioxins/furans. will be filtered and archived for potential analysis of dioxins/furans. The decision whether to analyze any of these archived samples for dioxins/furans will be made in consultation with EPA following the data review.

4.2 SAMPLE IDENTIFICATION AND SAMPLING METHODS

Sample identification and field sampling will be performed following the protocols described in this section. Contingencies may arise during field activities that require modification of the general procedures outlined herein. Such modifications will be made at the discretion of the FC after consultation with the Windward TM and PM, and the EPA representative in the field, if applicable. LDWG and EPA will be consulted if significant deviations from the sampling design are required. All modifications will be recorded in the protocol modification form (Appendix B).

4.2.1 Sample identification

Unique alphanumeric IDs will be assigned to each seep sample and recorded on the seep collection form (Appendix B).

The sample ID will include the following:

- Project area ID (i.e., LDW) and two-digit year
- Sample type (i.e., SP for seep)
- Sample location ID (Table 4-2)⁷

For example, the seep sample collected from location SP-30 will be identified as LDW18-SP-30.

All relevant information for each sample—including ID, date, time, and location—will be recorded on the seep collection form (Appendix B) and included as an appendix in the data report.

4.2.2 Seep sampling methods

The seep water sampling method will be determined in the field based on the location of the seep, the observed flow rate and the substrate conditions. A seep collection form (Appendix B) will be completed for each seep location. At least two photographs will be taken of each seep.

Prior to collecting each seep sample for chemical analysis, as described below, water quality parameters—temperature, conductivity, turbidity, pH, and DO—will be

⁷ Note that any newly identified seeps will be given a new seep location ID, and coordinates will be recorded in the field notes.

recorded again using a multi-parameter water quality meter. Salinity values will be calculated⁸ from the measured conductivity and temperature.

4.2.2.1 Seep originating from shoreline embankment

If a seep originates from a moderate or steep shoreline embankment and has turbidity ≤ 25 nephelometric turbidity unit (NTU),⁹ seep water will be collected by diverting flow through a pre-cleaned glass funnel and Masterflex® platinum-cured silicone tubing into a glass beaker for measurement of conventionals using the water quality meter. If the seep meets the conductivity criterion, then sample bottle will be filled directly (Figure 4-4). If turbidity is > 25 NTU, the sample will be allowed to settle in the stainless steel bowl for approximately 5 minutes prior to its transfer to sample bottles.

⁸ Salinity is determined from conductivity and temperature measurement. Calculation is based on algorithms in Standard Methods (SM).

⁹ The threshold of 25 NTU is based on best professional judgement. A turbidity benchmark value of 25 NTU is used in the current *Industrial Stormwater General Permit* (Ecology 2014). Additionally, water with turbidity of 25 NTU looks clear.

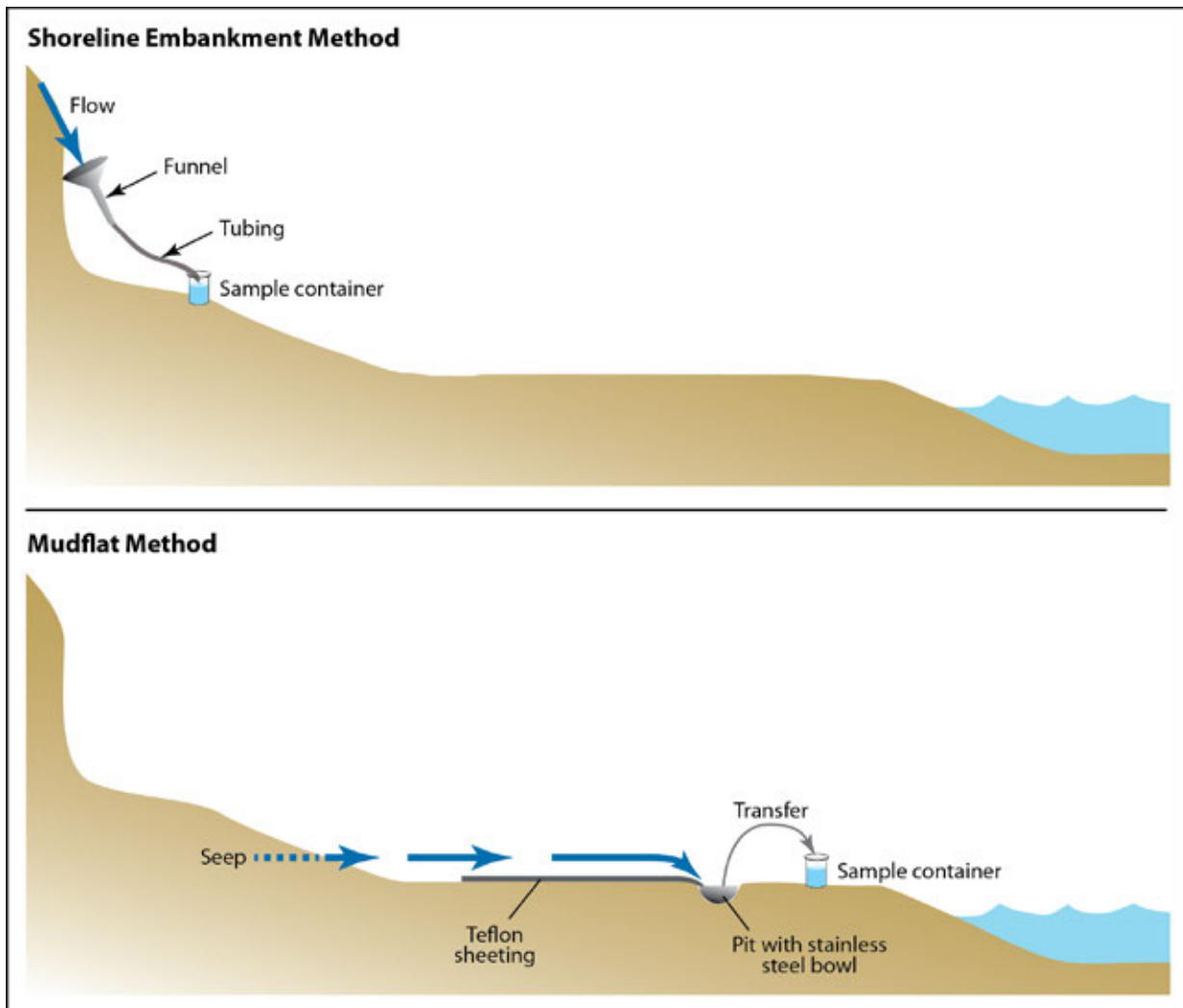


Figure 4-4. Seep sampling methods

4.2.2.2 Seep originating from mudflat

If a seep originates from an exposed mudflat, samples will be collected by diverting the seep water across pre-cleaned Teflon™ sheeting that is placed downgradient of the origin of the seep. The flow will be diverted into a pre-cleaned stainless steel bowl (Figure 4-4). Seep water will be transferred from the bowl to a glass beaker using a pre-cleaned stainless steel ladle for the measurement of conventional parameters using the water quality meter. If the seep water meets the conductivity criterion, sample bottles for chemistry analyses will also be filled using the ladle. If turbidity is > 25 NTU, the sample will be allowed to settle in the stainless steel bowl for approximately 5 minutes prior to transfer.

4.2.2.3 Sample collection contingencies

If seep flow is lower than anticipated on the day of sampling or if there is no flow, [bottles that can be filled within one hour will be filled, and](#) the field crew will return

one additional time during the sampling event [\(including the backup dates\)](#) at a different tide elevation to attempt sampling. [If the full volume required for all analyses cannot be collected, analyte priorities will be discussed with EPA and Ecology on a seep-by-seep basis.](#) If the flow rate is still insufficient, nearby seeps will be assessed to determine if they meet the criteria and can serve as representative seeps for the property. If no nearby seeps are available, EPA will be notified that seep water cannot be sampled at this location.

4.2.3 Field equipment

The items needed in the field for the chemical sampling of seep water are listed below. The FC will check that all equipment is available and in working order each day before sampling personnel go into the field. A rugged laptop computer complete with navigation software will accompany the FC at all times.

- | | |
|--|--|
| u QAPP | u Glass funnels |
| u Field sample collection forms | u Teflon™ sheeting and Masterflex® platinum-cured silicon tubing |
| u Field notebooks (Rite in the Rain®) | u Peristaltic pumps |
| u COC forms | u Stainless steel ladles |
| u Pens, pencils, Sharpies® | u Flexible Teflon™ sheeting |
| u GPS (w/extra batteries) | u Hydrolab |
| u Digital camera | u Extra membranes for Hydrolab DO probe |
| u Cellular phone | u Gloves |
| u Alconox® detergent and scrub brush | u Field notes from reconnaissance survey for seep locations |
| u Coolers | u Rubber boots |
| u Ice (wet and/or dry) | u Raingear |
| u LDW maps including property boundaries | u Waders |
| u Seep location coordinates | u Stopwatch |
| u Property access notification letters | u Reverse osmosis water |
| u Plywood | u Stainless steel bowls and glass beakers |
| u Squirt bottle with distilled water | u Pre-cleaned sample bottles |
| u Bucket for decontamination | |
| u Distilled water | |

Seep samples will be collected for all analyses at each seep if sufficient flow exists¹⁰ (see Section 4.4.2). ~~Sevenix~~ bottles will be filled at each seep for chemical analysis (see Section 4.5.6): one 250-mL amber glass bottle, one 500-mL high density polyethylene (HDPE) bottle, two 500-mL amber glass bottles, one 250-mL HDPE bottle, and ~~two~~ one 1-L amber glass bottles.

Samples for metals analysis will be handled following clean hands-dirty hands procedures. Samples collected for metals and organic analyses will be filtered and preserved as appropriate in the laboratory,¹¹ as discussed in Section 4.4.1.

4.3 SAMPLE HANDLING AND CUSTODY REQUIREMENTS

Sample custody is a critical aspect of environmental investigations. Sample possession and handling must be traceable from the time of sample collection, through laboratory and data analyses, to delivery of the sample results to the recipient. Procedures to be followed for sample handling, custody, and shipping are detailed in this section. In addition, procedures for decontamination of equipment and disposal of field-generated waste are described.

4.3.1 Sample handling procedures

At each laboratory, a unique sample identifier (termed either project ID or laboratory ID) will be assigned to each sample. The laboratory will ensure that a sample tracking record follows each sample through all stages of laboratory processing. The sample tracking record must contain, at a minimum, the names/initials of individuals responsible for performing the analyses, dates of sample extraction/preparation and analysis, and types of analyses being performed.

The FC will be responsible for reviewing seep sample information recorded on field collection forms (Appendix B), and will correct any improperly recorded information. Samples will be double bagged and immediately stored in coolers with wet ice. Sample labels will contain the project number, sampling personnel, date, time, and sample ID. Pertinent information about the sample, including its collection location, will be traceable through the sample label. A complete sample label will be affixed to each individual sample bottle. Labels will be filled out as completely as possible prior to each sampling event.

Samples will be placed on ice after collection and for transport to the laboratories. Sample packaging and transport information is summarized in Section 4.3.3.

¹⁰ In the event that seep volume is less than the minimum requirement, EPA will be consulted to determine the analytical priority for the specific seep location.

¹¹ Samples will be filtered in the laboratory as soon as possible following collection. Laboratory filtration under clean, controlled conditions greatly reduces the risk of sample contamination during filtration.

4.3.2 Sample custody procedures

Samples are considered to be in custody if they are: 1) in the custodian's possession or view; 2) in a secured place (under lock) with restricted access; or 3) in a container and secured with an official seal(s) such that the sample cannot be reached without breaking the seal(s). Custody procedures, described below, will be used for all samples throughout the collection, transportation, and analytical processes, and for all data and data documentation, whether in hard copy or electronic format. Custody procedures will be initiated during sample collection.

A COC form will accompany all samples to the analytical laboratory. Each person who has custody of the samples will sign the COC form and ensure that the samples are not left unattended unless properly secured. Minimum documentation of sample handling and custody will include:

- u Sample collection location, project name, and unique sample ID
- u Sample collection date and time
- u Any special notations on sample characteristics or problems
- u Name of the person who initially collected the sample
- u Date sample was sent to the laboratory
- u Shipping company name and waybill number

In the field, the FC will be responsible for all sample tracking and custody procedures. The FC will also be responsible for final sample inventory, and will maintain sample custody documentation. The FC or a designee will complete COC forms prior to removing samples from the sampling area. At the end of each day, and prior to sample transport to the laboratories, COC entries will be made for all samples. Information on the sample labels will be checked against sample log entries, and sample tracking forms and samples will be recounted. COC forms, which will accompany all samples, will be signed at each point of transfer. Copies of all COC forms will be retained and included as appendices to QA/QC reports and data reports. Samples will be shipped in sealed coolers.

The laboratories will ensure that COC forms are properly signed upon receipt of the samples, and will note any questions or observations concerning sample integrity on the COC forms. The laboratories will contact the FC and project QA/QC coordinator immediately if discrepancies are discovered between the COC forms and the sample shipment upon receipt.

4.3.3 Shipping requirements

Samples for analysis at ARI will be transported directly by field staff, and samples for analysis at Axys will be transported via courier. Prior to shipping, containers with samples will be wrapped in bubble wrap and securely packed inside a cooler with ice packs. The original signed COC forms will be placed in a sealed plastic bag and taped

to the inside lid of the cooler. Fiber tape will be wrapped completely around the cooler. On each side of the cooler, a *This Side Up* arrow label will be attached; a *Handle with Care* label will be attached to the top of the cooler, and the cooler will be sealed with a custody seal in two locations.

The temperature inside the cooler(s) containing the seep samples will be checked by the laboratory upon receipt of the samples. The laboratory will specifically note any coolers that do not contain ice packs, or that are not sufficiently cold ($\leq 4 \pm 2^{\circ}\text{C} \leq 6^{\circ}\text{C}$) upon receipt. All samples will be handled so as to prevent contamination or sample loss. Any remaining sample following analysis will be disposed of upon receipt of written notification by the Windward PM. Water sample holding times will vary by analysis, as summarized in Section 4.4.2.

4.3.4 Decontamination procedures

Water sampling requires strict measures to prevent sample contamination. Sources of extraneous contamination can include sampling gear, dust, ice chests, and ice used for cooling. All potential sources of contamination in the field will be identified by the FC, and appropriate steps will be taken to minimize or eliminate contamination. Ice chests will be scrubbed clean with Alconox® detergent and rinsed with distilled water after use to prevent potential cross contamination. To avoid contamination from melting ice, wet ice will be placed in separate plastic bags. Dedicated Teflon™ sheeting, Masterflex® platinum-cured tubing, and funnels will be cleaned by the laboratory prior to sampling. Between each sampling location, the field team will clean all non-dedicated sampling equipment with Alconox® phosphate-free detergent, rinse it with deionized water, and rinse it with site water.

4.3.5 Field-generated waste disposal

Excess sample water, generated equipment rinsates, and decontamination water¹² will be returned to each sampling location after sampling has been completed for that location. All disposable sampling materials and personal protective equipment (PPE) used in sample processing, such as disposable coveralls, gloves, and paper towels, will be placed in heavyweight garbage bags or other appropriate containers. Disposable supplies will be removed from the site by sampling personnel and placed in a standard refuse container for disposal as solid waste.

4.4 LABORATORY METHODS

Laboratories will meet the sample handling requirements and follow the procedures described in this section. In addition, analytical methods and data quality indicator (DQI) criteria are provided herein.

¹² Because decontamination water is an Alconox® water solution that is phosphate free, it can be returned to the sampling location for disposal.

4.4.1 Laboratory sample handling

Samples will be packed in coolers and held at $\leq 4 \pm 2^{\circ}\text{C} \leq 6^{\circ}\text{C}$. Samples for ARI will be directly delivered to the laboratory by field staff. Samples for Axys will be delivered via courier service.

Each sample will be filtered at its respective laboratory. Laboratory filtration will be performed for three reasons:

- 1) Filtration will remove any sediment that is entrained in the seep sample during sampling.
- 2) The dissolved phase is the mobile phase for groundwater chemical transport and is thus more relevant for source control.
- 3) Collecting both total and dissolved samples would require significantly more volume than the field crew will have time to collect at lower-volume seeps.

Filtration will be performed in the laboratory to reduce risk of contamination. Samples for dioxin/furan analyses will be filtered by Axys upon receipt. All other samples will be filtered at ARI after samples have been received and before preservatives are added. Samples for semivolatile organic compounds (SVOCs), ~~polychlorinated biphenyl~~ (PCB) Aroclors, polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticide analyses will be filtered through a 1- μm glass fiber filter to remove any non-colloidal particles greater than 1 μm that may have been introduced into the seep water by the sampling method. Samples for metals (including mercury) analyses will be filtered using a 0.45- μm polyvinylidene difluoride filter to represent the dissolved fraction.

4.4.2 Analytical methods

Chemical analysis of the seep samples will be conducted at ARI and Axys (Table 4-3). All analyses will be performed on the dissolved fraction of the seep water. Analytical methods and laboratory sample handling requirements for all measurement parameters are presented in Table 4-4.

Table 4-3. Procedures to be conducted at each analytical laboratory

Laboratory	Analyses to be Conducted	Individual Analytes
ARI	conventionals	DOC, TOC, and TSS
	metals	arsenic, cadmium, chromium, copper, lead, silver, zinc, mercury
	PAHs	acenaphthene, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(j)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, chrysene, dibenzo(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-cd)pyrene, 2-methylnaphthalene, naphthalene, phenanthrene, and pyrene
	PCB Aroclors ^a	Aroclor 1016, Aroclor 1221, Aroclor 1232, Aroclor 1242, Aroclor 1248, Aroclor 1254, Aroclor 1260, Aroclor 1262, and Aroclor 1268
	SVOCs	1,2-dichlorobenzene, 1,2,4-trichlorobenzene, 1,4-dichlorobenzene, 2,4-dimethylphenol, 4-methylphenol, benzoic acid, benzyl alcohol, bis(2-ethylhexyl)phthalate, butyl benzyl phthalate, dibenzofuran, dimethyl phthalate, hexachlorobenzene, n-nitrosodiphenylamine, PCP, and phenol
Axys	dioxin/furan congeners	2,3,7,8-TCDD, 1,2,3,7,8-PeCDD, 1,2,3,4,7,8-HxCDD, 1,2,3,6,7,8-HxCDD, 1,2,3,7,8,9-HxCDD, 1,2,3,4,6,7,8-HpCDD, OCDD, 2,3,7,8-TCDF, 1,2,3,7,8-PeCDF, 2,3,4,7,8-PeCDF, 1,2,3,4,7,8-HxCDF, 1,2,3,6,7,8-HxCDF, 1,2,3,7,8,9-HxCDF, 2,3,4,6,7,8-HxCDF, 1,2,3,4,6,7,8-HpCDF, 1,2,3,4,7,8,9-HpCDF, and OCDF

^a If PCB Aroclors are not detected with an RL greater than 39 ng/L (Ecology 2016), then the archived sample for this seep will be analyzed for PCB congeners at Axys. This analysis will include all 209 congeners.

ARI – Analytical Resources, Inc.
 Axys – Axys Analytical Services Ltd.
 DOC – dissolved organic carbon
 HpCDD – heptachlorodibenzo-*p*-dioxin
 HpCDF – heptachlorodibenzofuran
 HxCDD – hexachlorodibenzo-*p*-dioxin
 HxCDF – hexachlorodibenzofuran
 OCDD – octachlorodibenzo-*p*-dioxin
 OCDF – octachlorodibenzofuran
 PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl
 PCP – pentachlorophenol
 PeCDD – pentachlorodibenzo-*p*-dioxin
 PeCDF – pentachlorodibenzofuran
[RL – reporting limit](#)
 SVOC – semivolatile organic compound
 TCDD – tetrachlorodibenzo-*p*-dioxin
 TCDF – tetrachlorodibenzofuran
 TOC – total organic carbon
 TSS – total suspended solids

Table 4-4. Analytical methods and sample handling requirements for seep samples

Parameter ^a	Method	Reference	Extraction Solvent	Cleanup	Laboratory	Container	Preservative	Sample Holding Time
TSS	gravimetric	SM 2540 D-97	na	na	ARI	500-mL HDPE	cool to $\leq 4 \pm 2^{\circ}\text{C} \leq 6^{\circ}\text{C}$	7 days
TOC	high-temperature combustion	SM 5310 B-00	na	na	ARI	250-mL amber glass	cool to $\leq 4 \pm 2^{\circ}\text{C} \leq 6^{\circ}\text{C}$; sulfuric acid to pH < 2	28 days
DOC	high-temperature combustion	SM 5310 B-00	na	na	ARI	250-mL amber glass	cool to $\leq 4 \pm 2^{\circ}\text{C} \leq 6^{\circ}\text{C}$; 0.45 μm filter within 48 hours; sulfuric acid to pH < 2	28 days
Metals	ICP-MS	EPA 6020A UCT-KED	na	na	ARI	250-mL HDPE	nitric acid to pH < 2; samples filtered with 0.45- μm filter	6 months
Mercury	CV-AFS	EPA 7470A	na	na	ARI	250-mL HDPE or glass bottle	nitric acid to pH < 2; samples filtered with 0.45- μm filter	28 days
PAHs	GC/MS	EPA 3510C/ EPA 8270D-SIM	DCM	silica gel (EPA 3630C)	ARI	500-mL amber glass	cool to $\leq 4 \pm 2^{\circ}\text{C} \leq 6^{\circ}\text{C}$; samples filtered with 1- μm filter	7 days until extraction, 40 days after extraction; store extracts at $\leq 6^{\circ}\text{C}$ and in the dark
PCB Aroclors ^b	GC/ECD	EPA 3310-C Mod EPA 8082A	hexane	acid (EPA 3665A); sulfur with TBAS (EPA 3660B), silica gel (EPA 3630C)	ARI	1-L amber glass	cool to $\leq 4 \pm 2^{\circ}\text{C} \leq 6^{\circ}\text{C}$; samples filtered with 1- μm filter	7 days until extraction, 40 days after extraction; store extracts at $\leq 6^{\circ}\text{C}$ and in the dark
PCB congeners ^b	HRGC/HRMS	EPA 1668a	DCM	biobead multi-layered acid/base silica, silica, florisil	Axys	1-L amber glass	cool to $\leq 4 \pm 2^{\circ}\text{C}$; samples filtered with 1- μm filter	1 year until extraction and 1 year after extraction if stored at $\leq 10^{\circ}\text{C}$

Parameter ^a	Method	Reference	Extraction Solvent	Cleanup	Laboratory	Container	Preservative	Sample Holding Time
SVOCs	GC/MS	EPA 3510C/ EPA 8270D	DCM	none	ARI	500-mL amber glass	cool to $\leq 4 \pm 2^{\circ}\text{C}$ $\leq 6^{\circ}\text{C}$; samples filtered with 1- μm filter	7 days until extraction, 40 days after extraction; store extracts at $\leq 6^{\circ}\text{C}$ and in the dark
Dioxins/ furans	HRGC/ HRMS	EPA 1613B	DCM/hexane	biobead multi-layered acid/base silica, florisil, alumina, carbon/celite	Axys	1-L amber glass	cool to $\leq 4 \pm 2^{\circ}\text{C}$ $\leq 6^{\circ}\text{C}$; samples filtered with 1- μm filter	store in the dark at 0– 4°C; store extracts for up to 1 year at $\leq 10^{\circ}\text{C}$

^a Individual analytes are listed in Table 4-3.

^b [If PCB Aroclors are not detected with an RL greater than 39 ng/L \(Ecology 2016\), then the archived sample for this seep will be analyzed for PCB congeners at Axys.](#)

ARI – Analytical Resources, Inc.

Axys – Axys Analytical Services Ltd.

CV-AFS – cold vapor-atomic fluorescence spectrometry

DCM – dichloromethane

DOC – dissolved organic carbon

ECD – electron capture data

EPA – US Environmental Protection Agency

GC – gas chromatography/mass spectrometry

HDPE – high-density polyethylene

HRGC/HRMS – high-resolution gas chromatography/high-resolution mass spectrometry

ICP-MS – inductively coupled plasma-mass spectrometry

na – not applicable or not available

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

[RL – reporting limit](#)

SIM – selected ion monitoring

SM – Standard Methods

SVOC – semivolatile organic compound

TBAS – tetrabutylammonium sulfite

TOC – total organic carbon

TSS – total suspended solids

UCT-KED – universal cell technology-kinetic energy discrimination

~~All seep~~ The seep samples will be analyzed for ~~dissolved the~~ analytes included in ROD Tables 19 and 20,¹³ with the exception of dioxin/furans, which will be initially analyzed in a subset of the seeps.¹⁴ An archive sample will be collected for each seep. This 1-L sample will be filtered upon receipt by the laboratory, and will be used in the following ways: subset of samples (Section 4.1) will not be analyzed for dioxin/furans.

- u Samples to be analyzed initially for dioxins/furans will be co-extracted for dioxins/furans and PCB congeners; part of the extract will be analyzed for dioxins/furans, and part of the extract will be archived for potential PCB congener analysis if needed.
- u Samples that are not being analyzed initially for dioxins/furans will be archived; these samples could be used for analysis of dioxins/furans, PCB congeners, or both.
- u Based on the PCB Aroclor RLs achieved for each of the seep samples, PCB congeners will be analyzed for a seep if PCB Aroclors are not detected and the RL is greater than 39 ng/L.¹⁵
- u Based on the sediment and bank data screen, additional dioxin/furan analyses may be conducted based on the data review and analysis criteria.

RL goals for all individual analytes are listed in Appendix C. The RL goals will be sufficient to obtain results below Washington State marine chronic water quality standards, except for pentachlorophenol. The water quality standards are provided (Appendix C) only to demonstrate method sensitivity. Study goals do not include comparison of seep results to water quality standards. The RL values represent the lowest concentrations at which the laboratory can quantitatively measure and report results obtained using the methods listed in Table 4-4.

4.5 ANALYTICAL DATA QUALITY OBJECTIVE AND CRITERIA

The analytical data quality objective (DQO) for seep samples is to develop and implement procedures that will ensure the collection of representative data of known, acceptable, and defensible quality. Parameters used to assess data quality are precision, accuracy, representativeness, comparability, completeness, and sensitivity.

¹³ Analytes in ROD Tables 19 (titled *Cleanup levels for PCBs, arsenic, cPAHs, and dioxins/furans in sediment for human health and ecological COCs (RAOs 1, 2, and 4)*) and 20 (titled *Sediment cleanup levels for ecological [benthic invertebrate] COCs for RAO 3*) include metals, PAHs, SVOCs, PCBs, and dioxins/furans. Individual analytes are listed in Table 4-3.

¹⁴ Analytes in ROD Tables 19 (titled *Cleanup levels for PCBs, arsenic, cPAHs, and dioxins/furans in sediment for human health and ecological COCs (RAOs 1, 2, and 4)*) and 20 (titled *Sediment cleanup levels for ecological [benthic invertebrate] COCs for RAO 3*) include metals, PAHs, SVOCs, PCBs, and dioxins/furans. Individual analytes are listed in Table 4-3.

¹⁵ Ecology (2016) estimates 39 ng/L PCBs for the protection of sediment.

These parameters are discussed in the following sections, and specific DQIs are presented in Section 4.5.6.

4.5.1 Precision

Precision is the measure of reproducibility among individual measurements of the same property, usually under similar conditions, such as multiple measurements of the same sample. Precision is assessed by performing multiple analyses on a sample; it is expressed as a RPD when duplicate analyses are performed, and as a %RSD when more than two analyses are performed on the same sample (e.g., triplicates). Precision is assessed by laboratory duplicate analyses (e.g., duplicate samples, MSDs, and LCS duplicates) for all parameters. Precision measurements can be affected by the nearness of a chemical concentration to the DL, whereby the percent error (expressed as either %RSD or RPD) increases. The DQI for precision varies depending on the analyte (Section 4.5.6). The equations used to express precision are as follows:

$$RPD = \frac{(\text{measured conc} - \text{measured duplicate conc})}{(\text{measured conc} + \text{measured duplicate conc})} \times 100$$

Equation 1a

$$\%RSD = (SD/D_{ave}) \times 100$$

Where:

$$SD = \sqrt{\frac{\sum (D_n - D_{ave})^2}{(n - 1)}}$$

Equation 1b

D = sample concentration
D_{ave} = average sample concentration
n = number of samples
SD = standard deviation

4.5.2 Accuracy

Accuracy is an expression of the degree to which a measured or computed value represents the true value. Accuracy may be expressed as a percentage recovery for MS and LCS analyses. The DQI for accuracy varies depending on the analyte (Section 4.5.6). The equation used to express accuracy for spiked samples is as follows:

$$\text{Percent recovery} = \frac{\text{spiked sample results} - \text{unspiked sample results}}{\text{amount of spike added}} \times 100$$

Equation 2

4.5.3 Representativeness

Representativeness is an expression of the degree to which data accurately and precisely represent an environmental condition. The sampling approach was designed to address the specific objectives described in Section 2.1. Assuming those objectives

are met, the samples collected should be considered adequately representative of the environmental conditions they are intended to characterize.

4.5.4 Comparability

Comparability is an expression of the confidence with which one dataset can be evaluated in relation to another dataset. Therefore, the sample collection and chemical and physical testing will adhere to EPA and SM analysis protocols.

4.5.5 Completeness

Completeness is a measure of the amount of data that is determined to be valid in proportion to the amount of data collected. The equation used to express completeness is as follows:

$$\text{Completeness} = \frac{\text{number of valid measurements}}{\text{total number of data points planned}} \times 100 \quad \text{Equation 3}$$

The DQI for completeness for all components of this project is 90%. Data that have been qualified as estimated because the QC criteria were not met will be considered valid for the purpose of assessing completeness. Data that have been qualified as rejected will not be considered valid for the purpose of assessing completeness.

4.5.6 Sensitivity

Analytical sensitivity is the minimum concentration of an analyte above which a data user can be reasonably confident that the analyte was reliably detected and quantified. For this study, the MDL¹⁶ will be used as the measure of sensitivity for each measurement process. Tables 4-5 and 4-6 list specific DQIs for water quality measurements and laboratory analyses of seep samples. Standard seep volume requirements are specified to meet RLs for each particular analytical method. Table 4-7 summarizes the required analytical volumes for each analysis. Samples that require additional volume for QC are noted in the table.

Table 4-5. DQIs for water quality measurements

Parameter	Precision ^a	Accuracy ^b	Completeness
DO	± 20%	± 0.1 mg/L or 1% of reading	90%
pH	± 20%	± 0.2 pH unit	90%
Specific conductance	± 20%	± 0.5% of reading or 0.001 mS/cm	90%
Temperature	± 20%	± 0.05 °C	90%
Turbidity	± 20%	0–999 FNU: 0.3 FNU or ±2 % of reading, (whichever is greater); 1,000–4,000 FNU: ± 5% of reading	90%

Note: Water quality measurements will be made using a YSI® EXO1 or similar water quality meter.

^a Precision will be assessed by duplicate field measurements.

¹⁶ The term MDL includes other types of DLs such as EDL values calculated for dioxin/furan congeners.

^b Accuracy will be as reported for YSI® EXO1 instrument specifications.

DO – dissolved oxygen

DQI – data quality indicator

FNU – Formazin Nephelometric Unit

Table 4-6. DQIs for laboratory analyses

Parameter ^a	Unit	Precision ^b	Accuracy ^b		Completeness
			LCS	Spiked Samples	
TOC	mg/L	± 20%	80–120%	80–120%	90%
DOC	mg/L	± 20%	80–120%	80–120%	90%
TSS	mg/L	± 20%	90–110%	na	90%
Metals	µg/L	± 20%	75–125%	75–125%	90%
Mercury	µg/L	± 25%	80–120%	71–125%	90%
PAHs	µg/L	± 30%	30–160%	30–160%	90%
PCB Aroclors	µg/L	± 30%	51–128%	54–120%	90%
SVOCs	µg/L	± 30%	10–160%	10–160%	90%
Dioxins/ furans	pg/L	± 20%	70–130%	17–130%	90%

^a Individual analytes are listed in Table 4-3.

^b Values listed are performance-based limits provided by the laboratories.

DOC – dissolved organic carbon

DQI – data quality indicator

LCS – laboratory control sample

na – not applicable

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

ppt – parts per thousand

SVOC – semivolatile organic compound

TOC – total organic carbon

TSS – total suspended solids

Table 4-7. Analytical and target sample volumes

Analyte ^a	Required Analytical Sample ^b Volume (mL)	Additional Volume for Analytical QC (mL)	Target Sample Volume (mL)	Sample Bottle
ARI				
TOC	20	40	120 ^c	250-mL amber glass
DOC	20	40		
TSS	500	500	500	500-mL HDPE ^d
PAHs	500	1,000	500	500-mL amber glass ^e
PCB Aroclors	1,000	2,000	1,000	1-L amber glass ^f
SVOCs	500	1,000	500	500-mL amber glass ^e
Metals	25	50	135 ^c	250-mL HDPE
Mercury	20	40		
Axys				
Dioxin/furan and PCB congeners ^g	1,000	na	1,000	1-L amber glass

Analyte ^a	Required Analytical Sample ^b Volume ^b (mL)	Additional Volume for Analytical QC (mL)	Target Sample Volume (mL)	Sample Bottle
Total volume	3,585 mL	4,670 mL	3,755	6 bottles

^a Individual analytes are listed in Table 4-3.

^b The required analytical volume does not include volume for QA/QC, re-analysis, or spills.

^c The target volume for these analyses is less than the total volume of the sample volume. The field crew will collect the target volume and will fill the sample bottle whenever possible to minimize the head space in the sample bottle.

^d A second bottle will be collected for a field duplicate sample at a frequency of one per twenty samples.

^e Two additional 500-mL amber glass bottles will be collected at a frequency of one per twenty samples for a MS/MSD sample.

^f Two additional 1-L amber glass bottles will be collected at a frequency of 1 per 20 samples for a MS/MSD sample.

^g [Samples will be co-extracted or archived for dioxins/furans and PCB congeners analyses \(Section 4.4.2\).](#)

ARI – Analytical Resources, Inc.

Axys – Axys Analytical Services, Ltd.

DOC – dissolved organic carbon

EPA – US Environmental Protection Agency

HDPE – high-density polyethylene

MS – matrix spike

MSD – matrix spike duplicate

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

QA/QC – quality assurance/quality control

SVOC – semivolatile organic compound

TOC – total organic carbon

TSS – total suspended solids

4.6 QUALITY ASSURANCE/QUALITY CONTROL

The types of samples analyzed and the procedures conducted for QA/QC in the field and laboratory are described in this section.

4.6.1 Field quality control samples

Field QA/QC samples, such as field duplicates and equipment blanks, are generally used to evaluate the efficiency of field decontamination procedures and the variability attributable to sample handling. One equipment blank will be generated for each seep sampling procedure (shoreline embankment and mudflat) during the sampling event. A field duplicate will be collected if sufficient volume can be obtained at one of the seeps.

4.6.2 Laboratory quality control

Before analyzing the samples, the laboratory must provide written protocols for the analytical methods to be used, calculate RLs for each analyte in each matrix of interest as applicable, and establish an initial calibration curve for all analytes. The laboratory must also demonstrate its continued proficiency by participation in inter-laboratory comparison studies, and by repeated analysis of calibration checks, laboratory reagent and rinsate blanks, and spiked samples.

4.6.2.1 Sample delivery group

Project- and/or method-specific QC measures, such as MSs and MSDs or laboratory duplicates, will be analyzed per sample delivery group (SDG) preparatory batch, or

per analytical batch as specified in Table 4-8. A SDG is defined as no more than 20 samples, or those samples received at the laboratory within a 2-week period. Although a SDG may span two weeks, all holding times specific to each analytical method will be met for each sample in the SDG.

Table 4-8. Laboratory quality control sample analysis summary

Analysis Type	Initial Calibration	Initial Calibration Verification (second source)	Continuing Calibration Verification	LCS	Laboratory Replicates	MSs	MSDs	Method Blanks	Surrogate Spikes
TOC/DOC	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	na	1 per prep batch	na
TSS	na	na	na	1 per prep batch	1 per batch or SDG	na	na	1 per prep batch	na
Metals	prior to analysis	after initial calibration	every 10 samples	1 per prep batch	1 per batch or SDG	1 per batch or SDG	1 per batch or SDG	1 per prep batch	na
Mercury	prior to analysis	after initial calibration	beginning and end of each batch	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	3 per batch	na
PAHs	prior to analysis	after initial calibration	every 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
PCB Aroclors	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
SVOCs	prior to analysis	after initial calibration	every 10–20 analyses or 12 hours	1 per prep batch	na	1 per batch or SDG	1 per batch or SDG	1 per prep batch	each sample
Dioxins/furans	prior to analysis	after initial calibration	every 12 hours	1 per prep batch	na ^a	na	na	1 per prep batch	each sample

Note: A batch is a group of samples of the same matrix analyzed or prepared at the same time, not exceeding 20 samples.

^a Precision will be assessed by analysis of ~~the field duplicate. If a field duplicate is not available, the laboratory will analyze~~ an LCS duplicate.

DOC – dissolved organic carbon

LCS – laboratory control sample

MS – matrix spike

MSD – matrix spike duplicate

na – not applicable or not available

PAH – polycyclic aromatic hydrocarbon

PCB – polychlorinated biphenyl

SDG – sample delivery group

SVOC – semivolatile organic compound

TOC – total organic carbon

TSS – total suspended solids

4.6.2.2 Laboratory quality control samples

The analyst will review the results of the QC analyses from each sample group immediately after a sample group has been analyzed. The QC sample results will then be evaluated to determine whether control limits have been exceeded.

If control limits have been exceeded, then appropriate corrective action—such as recalibration followed by reprocessing of the affected samples—must be initiated before a subsequent group of samples is processed. The project QA/QC coordinator must be contacted immediately by the laboratory PM if satisfactory corrective action to achieve the DQIs outlined in this QAPP is not possible. All laboratory corrective action reports relevant to the analysis of project samples must be included in the data deliverable packages.

All primary chemical standards and standard solutions used in this project will be traceable to the National Institute of Standards and Technology (NIST), Environmental Resource Associates, National Research Council of Canada, or other documented, reliable, commercial sources. To determine their accuracy, standards will be validated by comparing them to independent standards. Laboratory QC standards are verified in various ways: second-source calibration verifications (i.e., same standard, two different vendors) are analyzed to verify initial calibrations; new working standard mixes (e.g., calibrations, spikes, etc.) are verified against the results of the original solution and must be within 10% of the true value; and newly purchased standards are verified against current data. Any impurities found in the standard will be documented.

The following sections summarize the procedures that will be used to assess data quality throughout sample analysis. Table 4-8 summarizes the QC procedures to be performed by the laboratories, as well as the associated control limits for precision and accuracy.

Method Blanks

Method blanks are analyzed to assess possible laboratory contamination at all stages of sample preparation and analysis. A minimum of one method blank will be analyzed for each SDG or for every 20 samples, whichever is more frequent.

Laboratory Control Samples

LCSs are prepared from a clean matrix using the same process used for the project samples that are spiked with known amounts of the target compounds. The recoveries of the compounds are used as a measure of the accuracy of the test methods.

Laboratory Replicate Samples

Laboratory replicate samples provide information on the precision of the analysis, and are useful in assessing potential sample heterogeneity and matrix effects. Laboratory replicates are subsamples of the original sample that are prepared and analyzed as separate samples, assuming sufficient sample matrix is available. A minimum of

1 laboratory replicate sample will be analyzed for each SDG or for every 20 samples, whichever is more frequent, for inorganic and conventional parameters.

Matrix Spikes and Matrix Spike Duplicates

The analysis of MS samples provides information on the extraction efficiency of the method on the sample matrix. By performing MSD analyses, information on the precision of the method is also provided for organic analyses. For organic analyses, a minimum of 1 MS/MSD pair will be analyzed for each SDG or for every 20 samples, whichever is more frequent, when sufficient sample volume is available, with the exception of dioxins/furans. For inorganic analyses (i.e., metals), a minimum of one MS sample will be analyzed for each SDG, when sufficient sample volume is available.

Surrogate Spikes

All project samples analyzed for organic compounds will be spiked with appropriate surrogate compounds, as defined in the analytical methods. Surrogate recoveries will be reported by the laboratories; however, no sample results will be corrected for recovery using these values.

Isotope Dilution Quantitation

All project samples analyzed for dioxin/furan congeners will be spiked with a known amount of surrogate compounds, as defined in the analytical methods. The labeled surrogate compounds will respond similarly to the effects of extraction, concentration, and GC. Data will be corrected for the recovery of the surrogates used for quantification.

Internal Standard Spikes

Internal standards may be used for calibrating and quantifying organic compounds and metals using MSs. If internal standards are required by the method, all calibration, QC, and project samples will be spiked with the same concentration of the selected internal standard(s). Internal standard recoveries and retention times must be within method and laboratory criteria.

4.7 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE

Prior to each field event, measures will be taken to test, inspect, and maintain all field equipment. All equipment used, including the multi-parameter water quality meter, differential GPS unit, and digital camera, will be tested for accuracy before leaving for the field event.

The FC will be responsible for overseeing the testing, inspection, and maintenance of all field equipment. The laboratory PM will be responsible for ensuring laboratory equipment testing, inspection, and maintenance requirements are met. The methods to be used in calibrating the analytical instrumentation are described in the following section.

4.8 INSTRUMENT/EQUIPMENT CALIBRATION AND FREQUENCY

Multipoint initial calibration will be performed on each analytical instrument at the start of the project, after each major interruption to the instrument, and when any continuing calibration does not meet the specified criteria. The number of points used in the initial calibration is defined in the relevant analytical method. Continuing calibrations will be performed daily for organic analyses, every 10 samples for inorganic analyses, and with every sample batch for conventional parameters to ensure proper instrument performance.

Calibration of analytical equipment used for chemical analyses includes the use of instrument blanks or continuing calibration blanks, which provide information on the stability of the baseline established. Continuing calibration blanks will be analyzed immediately after the continuing calibration verification, at a frequency of 1 blank for every 10 samples analyzed for inorganic analyses and 1 blank every 12 hours for organic analyses. If the continuing calibration does not meet the specified criteria, the analysis must stop. Analysis may resume after corrective actions have been taken to meet the method specifications. All project samples analyzed by an instrument found to be out of compliance must be reanalyzed.

The multi-parameter water quality meter will be used to collect *in situ* water quality data at each sampling location and associated with each seep sample, as outlined in this QAPP. All sensors, except those for temperature, require calibration to ensure high performance. The meter will be calibrated daily to ensure that the sensors meet the manufacturer's accuracy specifications for conductivity, DO, pH, and turbidity.

A Trimble® SPS461 or similar GPS receiver unit will be employed for the various sampling methods outlined in this QAPP. The GPS receiver will be calibrated daily to ensure that it is accurately recording positions from known benchmarks and functioning within the individual unit's factory specifications.

4.9 INSPECTION/ACCEPTANCE OF SUPPLIES AND CONSUMABLES

The FC will gather and check field supplies daily for satisfactory conditions before each field event. Batteries used in the digital camera will be checked daily and recharged as necessary. Supplies and consumables for the field sampling effort will be inspected upon delivery and accepted if the condition of the supplies is satisfactory.

4.10 DATA MANAGEMENT

All field data will be recorded on field forms, which the FC will check for missing information at the end of each field day and amend as necessary. A QC check will be done to ensure that all data have been transferred accurately from the field forms to the database. Field forms will be archived in the Windward library.

The analytical laboratories are required to submit data in an electronic format, as described in Section 3.7.2. The laboratory PM will contact the project QA/QC coordinator prior to data delivery to discuss specific format requirements.

A library of routines will be used to translate typical electronic output from laboratory analytical systems and to generate data analysis reports. The use of automated routines will ensure that all data are consistently converted to the desired data structures, and that operator time is kept to a minimum. In addition, routines and methods for quality checks will be used to ensure that such translations are correctly applied.

Written documentation will be used to clarify how field and analytical laboratory duplicates and QA/QC samples were recorded in the data tables, and to provide explanations of other issues that may arise. The data management task will include keeping accurate records of field and laboratory QA/QC samples so that project team members who use the data will have appropriate documentation. All data management files will be secured on the Windward network. Data management procedures outlined in Appendix C of the Work Plan will be followed (Windward and Integral 2017).

5 Assessment and Oversight

5.1 COMPLIANCE ASSESSMENTS AND RESPONSE ACTIONS

EPA or its designees may observe field activities during each sampling event, as needed. If situations arise wherein there is a significant inability to follow the QAPP methods precisely, the Windward PM will determine the appropriate actions and consult EPA (or its designee).

5.1.1 Compliance assessments

Laboratory and field performance assessments will consist of on-site reviews conducted by EPA of QA systems and equipment for sampling, calibration, and measurement. EPA personnel may conduct a laboratory audit prior to sample analysis. Any pertinent laboratory audit reports will be made available to the project QA/QC coordinator upon request. Analytical laboratories will be required to have written procedures addressing internal QA/QC. All laboratories and QA/QC coordinators will be required to ensure that all personnel engaged in sampling and analysis tasks have appropriate training.

5.1.2 Response actions for field sampling

The FC, or a designee, will be responsible for correcting equipment malfunctions throughout field sampling, and for resolving situations in the field that may result in nonconformance or noncompliance with this QAPP. All corrective measures will be immediately documented in the field logbook, and protocol modification forms will be completed.

5.1.3 Corrective action for laboratory analyses

Analytical laboratories will be required to comply with their current written standard operating procedures, laboratory QA plan, and analytical methods. All laboratory personnel will be responsible for reporting problems that may compromise the quality of the data. The analysts will identify and correct any anomalies before continuing with sample analysis. The laboratory PMs will be responsible for ensuring that appropriate corrective actions are initiated as required for conformance with this QAPP.

The project QA/QC coordinator will be notified immediately if any QC sample exceeds the DQIs outlined in this QAPP (Table 4-6) and the exceedance cannot be resolved through standard corrective action procedures. A description of the anomaly, the steps taken to identify and correct the anomaly, and the treatment of the relevant sample batch (i.e., recalculation, reanalysis, and re-extraction) will be submitted with the data package using the case narrative or corrective action form.

5.2 REPORTS TO MANAGEMENT

The FC will prepare a summary email for submittal to LDWG and EPA following each sampling day. The project QA/QC coordinator will prepare progress reports for submittal by email to LDWG and EPA on the following occasions: 1) after sampling has been completed and samples have been submitted for analysis, 2) when information is received from the laboratory, and 3) when analyses are complete. The status of the samples and analyses will be indicated, with emphasis on any deviations from this QAPP. A data report will be written after validated data are available, as described in Section 2.2.

6 Data Validation and Usability

6.1 DATA VALIDATION

The data validation process will begin in the laboratory with the review and evaluation of data by supervisory personnel or QA specialists. The laboratory analyst will be responsible for ensuring that the analytical data are correct and complete, that appropriate procedures have been followed, and that QC results are within acceptable limits. The project QA/QC coordinator will be responsible for ensuring that all analyses performed by the laboratories are correct, properly documented, and complete, and that they satisfy the analytical DQOs specified in this QAPP.

Data will not be considered final until validated. Data validation will be conducted following EPA guidance (EPA 2014a, 2016a, b, c).

Independent third-party data review and summary validation of the analytical chemistry data will be conducted by EcoChem or a suitable alternative. All data will undergo validation, and a minimum of 10% or one SDG will undergo full data validation. Full data validation parameters will include:

- u QC analysis frequencies
- u Analysis holding times
- u Laboratory blank contamination
- u Instrument calibration
- u Surrogate recoveries
- u LCS recoveries
- u MS recoveries
- u MS/MSD RPDs
- u Compound identifications—verification of raw data with the reported results (10% of analytes)
- u Compound quantitations—verification of calculations and RLs (10% of analytes)
- u Instrument performance check (tune) ion abundances
- u Internal standard areas and retention time shifts
- u [Ion abundance ratio compared to theoretical ratios for samples analyzed by EPA method 1613b](#)

If no discrepancies are found between reported results and raw data in the dataset that undergoes full data validation, then a summary validation of the rest of the data can proceed using all of the QC forms submitted in the laboratory data package. QA review of the seep chemistry data will be performed in accordance with the QA

requirements of the project, the technical specifications of the analytical methods indicated in Table 4-6, and EPA guidance for organic and inorganic data review (EPA 2016b, c). The EPA PM may have EPA peer review the third-party validation or perform data assessment/validation on a percentage of the data.

All discrepancies and requests for additional, corrected data will be discussed with the laboratories prior to issuance of the formal data validation report. The project QA/QC coordinator will be informed of all contacts with the laboratories during data validation. Review procedures used and findings made during data validation will be documented on worksheets. The data validator will prepare a data validation report that will summarize QC results, qualifiers, and possible data limitations. This data validation report will be appended to the data report. Only validated data with appropriate qualifiers will be released for general use.

6.2 RECONCILIATION WITH DATA QUALITY OBJECTIVES

Data QA will be conducted by the project QA/QC coordinator in accordance with EPA guidelines (EPA 2016b, c). The results of the third-party independent review and validation will be reviewed, and cases wherein the project DQOs were not met will be identified. The usability of the data will be determined in terms of the magnitude of the DQO exceedance.

7 References

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